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## Contingency Base Camp Solid Waste Generation

Stephen D. Cosper, H. Garth Anderson, Kurt Kinnevan,  
and Byung J. Kim

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# **Contingency Base Camp Solid Waste Generation**

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## Abstract

Solid waste management is an important engineering function at Forward Operating Bases (FOBs). Due to the contingency nature of base operations and daily life at the FOB, waste generation is likely to be always higher than Continental United States (CONUS) on a per soldier basis. To improve operational effectiveness and efficiency, there is a need to gather baseline information on which to evaluate the performance of new technologies and approaches to solid waste management. To fill this data gap, the Army Study Program funded a group of studies for power, water, and waste management. This specific work characterized and quantified solid waste generation, which includes septage (“blackwater”) generation, at the “per soldier” and base camp level.

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## Preface

This study was conducted for Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASAALT) under Project AMSCO 622784T4100, “Military Facilities Engineering Technology,” Work Unit 122G16, “Forward Operating Bases.” The technical monitor was John Munroe, US Army Natick RD&E Center, PM-FSS.

The work was managed and executed by the Environmental Processes Branch (CN-E) of the Installations Division (CN), Construction Engineering Research Laboratory (CERL). The CERL principal investigator was H. Garth Anderson. Deborah R. Curtin is Chief, CEERD-CN-E, and Dr. John T. Bandy is Chief, CEERD-CN. The associated Technical Director was Alan Anderson, CEERD-CV-T. The Director of ERDC-CERL is Dr. Ilker R. Adiguzel.

CERL is an element of the US Army Engineer Research and Development Center (ERDC), US Army Corps of Engineers. The Commander and Executive Director of ERDC is COL Kevin J. Wilson, and the Director of ERDC is Dr. Jeffery P. Holland.



# 1 Introduction

## 1.1 Background

Over the past few decades, Army training and doctrine has evolved to emphasize military operational aspects (i.e., mission), and to de-emphasize aspects of soldier and camp sustainment. The rationale for this shift is that, in short term campaigns, soldiers can deploy with or take care of their own support needs, while long-term deployments will be supported by contractor staff. This approach has proven generally effective in Iraq and Afghanistan.

However, as these conflicts and deployments have continued, some flaws in this rationale have come to light. First, in larger base camps where contractors provide all support services, there is little consistent knowledge throughout the Army on quantities of utilities used (or required). Contractors have little incentive to collect and submit such information. This lack of data makes camp planning difficult and provides little opportunity for economizing measures since it is hard to get the “big picture” for planning purposes. Second, contractor service at the smaller, more remote camps is limited. Consequently, soldiers who have had little training for the tasks must take on engineering and housekeeping functions, which takes time away from mission activities.

To improve operational effectiveness and efficiency, there is a need to gather baseline information on which to evaluate the performance of new technologies and approaches. To fill this data gap, the Army Study Program funded a group of studies for power, water, and waste management. This specific work was undertaken to characterize and quantify solid waste generation, which includes septage (“blackwater”) generation, “per soldier” and at the base camp level. Table 1 lists the camp sizes considered in this report.

Table 1. Reference base camp sizes.

Type	Military	Civilians	PAX
Company	120	0	120
Battalion	600	400	1,000
Brigade	6,000	6,000	12,000

## 1.2 Objectives

The overall objectives of this work are to improve utility and sustainment protocols at Contingency Base Camps. The specific objective of this initial stage of work (and the first logical step) is to characterize and quantify solid waste generation, which includes septage (“blackwater”) generation, “per soldier” and at the base camp level.

## 1.3 Approach

The objectives of this work were met in the following steps:

1. Army guidance documents and open literature were reviewed for any waste generation data or descriptions of relevant base camp waste management practices.
2. Researchers gathered data on current practices through:
  - a. electronic communication with installation managers
  - b. interviews with personnel who had recently returned from performing Directorate of Public Works (DPW) type functions in theater
  - c. visits to Continental United States (CONUS) training forward operating bases (FOBs) at Camp Atterbury, IN and Camp Shelby, MS to assess their “realism” and to collect utility data.
  - d. A site visit by a CERL researcher deployed to Afghanistan as an Army Reservist, who interviewed base camp personnel and made observations on solid waste management.
3. Results of this work were compiled and analyzed, and conclusions were drawn.

## 1.4 Scope

Two main constraints limit the depth of information that collected for this report. First, much of the waste management service to the deployed Army is provided by contract; therefore, data on these activities is not forthcoming. Secondly, researchers are limited in the length of time spent in-theater for first hand observations of waste management practices.

Nevertheless, information in this report should be widely applicable, at least in terms of methodology. Information presented herein is intended to apply to current Army deployments. While technology could be fielded to rapidly change solid waste *management* practices, solid waste *generation* rates would be less likely to vary in future deployments.

## 1.5 Mode of Transfer

It is anticipated that the results of this study will inform and support:

- several Major Objectives of the 2008 Army Campaign Plan as outlined in the 18 June 2008 Execution Order (EXORD) (HQDA 2008)
- the current Base Camp Integrated Capabilities Development Team (ICDT) assessments that the US Army Maneuver Support Center (MANSCEN) are performing for the US Army Training and Doctrine Command (TRADOC)
- the development of interoperable systems across the US Department of Defense (DOD).

This report will be made accessible through the World Wide Web (WWW) at URLs: <http://www.cecer.army.mil> and <http://libweb.erdclib.usace.army.mil>

## 2 Solid Waste Generation

This Chapter presents data gathered on generation rates and types of solid wastes (i.e., trash) at base camps.

### 2.1 Army Guidance

#### 2.1.1 FM 3-34.5

Field Manual (FM) 3-34.5, *Environmental Considerations* (HQDA 2010) contains planning guidance for integrating environmental activities into general operating plans. This manual does not contain information regarding generation rates of wastes.

#### 2.1.2 GSTM 3-34.56 Waste Management Operations

General Subject Technical Manual (GSTM) 3-34.56 (which, at the time of this writing is an initial draft not ready for implementation) is intended to provide information to base camp planners to enable them to provide the necessary facilities for solid waste management at future base camps. The manual also provides planning information for the management of black water. GSTM 3-34.56 quantifies solid water generation and black water generation rates in several contexts:

1. Preface, line 1: “A soldier in the field can generate 20 pounds of solid waste and 80 pounds of liquid waste per day.”
2. Paragraph 3-21 (Composting): “A base camp population of 2,500 can produce approximately 5,500 cubic meters, or 1,500 tons, of compostable solid waste (SW) (including sewage sludge) per year.
3. Paragraph 3-63 (Develop Preliminary Waste Estimates): “For units on the move or not situated in a base camp, planners use a generation rate of 4 pounds per person per day as a general rule of thumb.
4. Table 3-2, p. 3-14: This table presents planning factors for components of solid waste assuming none is being reused or recycled.

Table 2 lists the non-hazardous solid waste generation rates given in GSTM 3-34.56.

Table 2. Non-hazardous solid waste generation rates from GSTM 3-34.56.

Generation Rates "on the move"		Generation Rates in Base Camps	
Component	Rate (lbs/person/day)	Component	Rate (lbs/person/day)
General refuse	1.5	Plastic bottles	0.54
Food waste	2.5	Other plastic	1.38
Total	4	Aluminum	0.13
		Cardboard	1.45
		Paper	2.67
		Food waste	1.67
		Textiles	0.26
		Glass	0.1
		Scrap wood	2.95
		Miscellaneous	2.3
		Total	18.2

## 2.2 Site studies

### 2.2.1 The Balkans

#### 2.2.1.1 Base Camp Solid Waste Characterization Study

ERDC/CERL TR-06-24, *Base Camp Solid Waste Characterization Study* (Gerdes and Jantzer 2006) characterizes nonhazardous solid wastes generated at Army base camps. The data in this report were obtained from solid waste characterization surveys of base camps in Bosnia, Kosovo, and Bulgaria. The report describes the nature of base camp solid waste and how solid waste management varies with mission maturity. It also documents the field surveys and other data sources used to compile the comprehensive solid waste characterization schedules. Figure 1 shows the solid waste sorting being done at Eagle Base, Tuzla, Bosnia in 2003.



Source: Tucker et al. (2004).

Figure 1. Personnel search through mixed waste during June 2003 Eagle Base Survey.

Table 3. Base camp solid waste production by soldier.

Material	lb/yr/soldier	lb/day/soldier	kg/yr/soldier	kg/day/soldier	% of total
Plastic bottles*	295	<i>0.808</i>	134	<i>0.367</i>	5.1%
Polystyrene	9.3	<i>0.025</i>	4.2	<i>0.012</i>	0.2%
Other plastics	143	<i>0.392</i>	65	<i>0.178</i>	2.5%
Aluminum	10	<i>0.027</i>	4.7	<i>0.013</i>	0.2%
Other metals	11	<i>0.030</i>	4.8	<i>0.013</i>	0.2%
Corrugated paper	349	<i>0.956</i>	158	<i>0.433</i>	6.0%
Other paper	179	<i>0.490</i>	81	<i>0.222</i>	3.1%
Scrap wood	4,151	<i>11.373</i>	1,883	<i>5.159</i>	72%
Kitchen food waste	328	<i>0.899</i>	149	<i>0.408</i>	5.7%
Post-consumer food waste	51	<i>0.140</i>	23	<i>0.063</i>	0.9%
WWTP sludge (dry weight)**	70	<i>0.192</i>	32	<i>0.088</i>	1.2%
Sawdust	47	<i>0.129</i>	21	<i>0.058</i>	0.8%
Grass clippings	39	<i>0.107</i>	18	<i>0.049</i>	0.7%
Glass	40	<i>0.110</i>	18	<i>0.049</i>	0.7%
Textiles	25	<i>0.068</i>	11	<i>0.068</i>	0.4%
Medical waste	13	<i>0.036</i>	6.1	<i>0.036</i>	0.2%
Rubber	3.9	<i>0.011</i>	1.8	<i>0.011</i>	0.1%
Miscellaneous	5.3	<i>0.015</i>	2.4	<i>0.015</i>	0.1%
Total***	5,769	<i>15.8</i>	2,617	<i>7.2</i>	100%

\* Reflects 100% drinking water distribution via disposable bottled water

\*\* WWTP sludge weight expressed as 100% solids – multiply by 5 for a cake and multiply by 50 for a liquid

\*\*\* Survey includes all discarded solid waste except hazardous waste, recycled scrap metal, and salvaged construction material and equipment.

Above values do not reflect additional loadings due to Transfer of Authority (TOA) rotations (estimated to increase annual waste production by approximately 1 month for bi-annual TOAs)

Above values are based on relatively short-term studies and reflect a population “snapshot.” It is not known whether this table accurately includes the fraction of solid wastes generated by host-nation contract employees and transient combatants.

Table 3 lists the comprehensive base camp waste characterization that was developed based on the evaluations of this study. The Wastewater Treatment Plant (WWTP) sludge production was based on studies at wastewater treatment plants at three base camps. Note that the most significant component is waste wood, which is primarily pallets, shipping crates, and construction/demolition waste.

#### 2.2.1.2 Solid Waste Generation Rates at Army Base Camps

The study described in the previous section characterized wastes generated by a camp that had recently transitioned from combat operations to stability operations. PWTB 200-1-51, *Solid Waste Generation Rates at Army Base Camps* (HQUSACE 2008) described a second study conducted in 2006 that characterized wastes generated by a camp that had matured to the extent that the infrastructure was largely semi-permanent and was

capable of sustaining long-term missions. Table 4 lists the results of two characterization studies in the Balkans, side by side, for comparison.

### 2.2.2 Fort Polk, LA

Hughes Associates, Inc., conducted a study for the Research, Development, and Engineering Command (RDECOM) in June 2000 to characterize wastes generated at the Force Provider training site at Fort Polk, LA. The study involved collecting and sorting wastes from the Force Provider camp over a 6-day period. The Force Provider camp at Fort Polk provided a living scenario similar to deployment for soldiers who trained there. However, several types of solid wastes were not generated at that training camp during that study that would be generated at an actual deployment, including shipping wastes, wastewater treatment solids, office wastes, plastic bottles, some metal waste, and textiles. The reasons for these differences are the short term nature of training, and that utilities at the Force Provider camp (including water supply and wastewater treatment) were provided by connections to the Fort Polk infrastructure. The wastes characterized from the Force Provider were primarily generated from the dining facility and the soldiers' quarters. Table 5 lists the reported generation rates.

Table 4. Results of two characterization studies in the Balkans.

Component	2006 Data (Camp B)			2003 Data (Camp A)		
	lb/person/yr	lb/person/day	Percent	lb/person/yr	lb/person/day	Percent
Plastic bottles	196	<i>0.537</i>	3.0	295	<i>0.808</i>	5.1
Other plastic	502	<i>1.375</i>	7.6	143	<i>0.392</i>	2.5
Aluminum	46	<i>0.126</i>	0.7	10	<i>0.027</i>	0.2
Light metal	202	<i>0.553</i>	3.0	11	<i>0.030</i>	0.2
Cardboard (and paper)	529	<i>1.449</i>	8.0	349	<i>0.956</i>	6.1
Other paper	974	<i>2.668</i>	14.7	179	<i>0.490</i>	3.1
Food and vegetation waste	609	<i>1.668</i>	9.2	418	<i>1.145</i>	7.3
Textiles	95	<i>0.260</i>	1.4	25	<i>0.068</i>	0.4
Glass	37	<i>0.101</i>	0.6	40	<i>0.110</i>	0.7
Rubber	4	<i>0.011</i>	0.1	4	<i>0.011</i>	0.1
Polystyrene	21	<i>0.058</i>	0.3	9	<i>0.025</i>	0.2
Scrap wood	1076	<i>2.948</i>	16.2	4151	<i>11.373</i>	72.1
Sewage sludge	688	<i>1.885</i>	10.4	70	<i>1.885</i>	1.2
Ashes	811	<i>2.222</i>	12.2	0	<i>2.222</i>	0.0
Miscellaneous	838	<i>2.296</i>	12.6	52	<i>2.296</i>	0.9
Total	6628 :: 6627	<i>36.3</i>	100	5756	<i>15.8</i>	100.1

Table 5. Solid waste generated at the Force Providers training site.

Component	lb/(person-day)
Trash and kitchen waste (minus slop food)	3.2
Slop food	0.7
Cooking oil	0.2
Total	4.3

### 2.2.3 Camp Atterbury, IN

Camp Atterbury, IN is a National Guard installation that has established three training FOBs in recent years (developed by the 205<sup>th</sup> Infantry Brigade, LTC Craig Johnson, Battalion Commander). These three sites were developed to host soldiers from several other CONUS installations for their required pre-deployment training. These training missions are designed to familiarize outgoing soldiers with in-theater living conditions, security procedures, etc. The training realism is thought to be fairly good. Soldiers live in trailers (Figure 2), shower in trailers, use portable toilets, dine in the dining facility (DFAC), etc.

FOB 3 is especially attractive for these utility studies because power and water are metered separately from the rest of the installation. Also, the DPW oversees solid waste and septage hauling contracts.

Table 6 lists recent solid waste generation figures.

### 2.2.4 Camp Shelby, MS

Camp Shelby is a National Guard installation near Hattiesburg, MS. Like Camp Atterbury, it hosts a busy pre-deployment training schedule. There are four training Contingency Operating Locations (COLs), a term synonymous with FOB. CERL researchers visited the site in September 2010 to collect utility usage data, and attempt to correlate that with COL population. Figure 3 shows COL 4, the largest with a capacity of 1434 soldiers, roughly half in tents and half in containerized housing units (CHUs).



Figure 2. Barracks at Camp Atterbury, FOB 3.

Table 6. Solid waste generation at Camp Atterbury, FOB 3.

Unit	Jun 2009	Jul 2009	Aug 2009	Sep 2009	Oct 2009	Nov 2009	Dec 2009	Jan 2010	Avg
PAX.	620	1120	570	640	730	350	225	180	554
cu yd/month	144	112	80	144	96	56	48	136	102
lb/month	32,400	25,200	18,000	32,400	21,600	12,600	10,800	30,600	22,950
lb/(PAX-day)	1.74	0.75	1.05	1.69	0.99	1.20	1.60	5.67	1.84



Figure 3. COL 4 at Camp Shelby.

## 2.2.5 Afghanistan

In January 2011, a CERL researcher who is an Army Reserve Engineer Officer traveled to Afghanistan and visited four contingency base camps: New Kabul Compound, Camp Phoenix, FOB Salerno, and Camp Leatherneck. The researcher conducted interviews with base camp mayor staffs and contract support personnel, and made observations on solid waste management operations. However, no formal data was collected from the waste streams.

### 2.2.5.1 *Camp Phoenix and New Kabul Compound*

Camp Phoenix and the New Kabul Compound are urban base camps that are part of the Kabul Base Cluster. Solid waste at both these facilities is collected by a contractor and hauled off base for disposal. Any type of on-site burning (open pit or incinerator) is not feasible due to the lack of space and the overall poor air quality in the Kabul metropolitan area. Both facilities have made a good effort to segregate waste streams and recycle when feasible. No data were available on daily waste generation rates. Figures 4 and 5 shows the solid waste collection at Camp Phoenix and the New Kabul Compound, respectively. Figures 6 and 7 show New Kabul Compound recycling bins and battery disposal.

### 2.2.5.2 *FOB Salerno*

FOB Salerno is a remote base camp located near the Pakistani border that has an approximate population of 5600. Solid waste at the site was collected in contractor furnished disposal bins and hauled by the contractor to their burn pit. Soldiers were generally not involved in the collection and disposal process. The Logistics Civil Augmentation Program (LOGCAP) contractor estimated an average disposal volume of 250 m<sup>3</sup>/day, which is equivalent to 13.1 lb/person/day. All incoming loads were dumped into a holding area for inspection and segregation. Waste streams went to several locations in the facility. Usable military materiel was set aside for later reuse. Non-burnable scrap such as metal was stockpiled for later recycling. Wet DFAC waste was put into an open pit to be burned using scrap wood for combustion. All plastics were removed from the waste stream and stockpiled in a large pit. Because the base was remote, there was no market for plastic recycling; as a result, the site had accumulated a large quantity of plastic bottles that could not be properly disposed of. Finally, combustible solid waste was burned in an air-curtain burn box.



Figure 4. Solid waste collection at Camp Phoenix.



Figure 5. Solid waste collection at New Kabul compound.



Figure 6. Recycling bins at New Kabul Compound.



Figure 7. Battery disposal at New Kabul Compound.

The average disposal volume at FOB Salerno of 13.1 lb/person/day is slightly lower than the recommended planning factor. Although there was a moderate amount of construction at this base, most was done using locally manufactured brick and cast concrete, which generates very little construction debris requiring disposal. Also at the time of the visit, there was little turnover of base units and personnel, which significantly decreased the amount of waste packing and shipping materials. Figure 8 shows solid waste disposal operations at FOB Salerno; Figure 9 shows a burn box and residual ash; Figure 10 shows waste segregation, and Figure 11 shows stockpiled plastic waste.



Figure 8. Salerno solid waste disposal operations.



Figure 9. Burn box and residual ash.



Figure 10. Salerno waste segregation.



Figure 11. Stockpiled plastic waste at Salerno.

### 2.2.5.3 *Camp Leatherneck*

Camp Leatherneck is a large Marine Corps base in southwestern Afghanistan that has an estimated population of 20,000. Solid waste at Camp Leatherneck was collected by both contractors and troop units, and was delivered to a contractor-operated burn pit. Incoming loads were inspected and logged by contractors and directed to a specific area of the burn pit operation. Non-burnable materials and plastics were segregated and stockpiled for recycling or landfilling. Combustible materials were piled in the burn area where active burning operations were conducted by trained contractor personnel. A LOGCAP contractor report estimated processing 300,000 lb/day (15 lb/person/day). This base camp has a solid waste incinerator that was nearing completion at the time of the visit.

The solid waste generation rate of 15 lb/person/day validates the recommended planning factor of 15.9 lb/person/day. Because of the high levels of new conventional construction and unit turnover, construction debris and packing/shipping materials volume were substantial. Figure 12 shows load inspection at Camp Leatherneck; Figure 13 shows waste segregation; Figures 14 and 15 show active burn operations; and Figures 16 and 17 show an incinerator under construction.



Figure 12. Load inspection at Camp Leatherneck.



Figure 13. Waste segregation at Camp Leatherneck.



Figure 14. Camp Leatherneck active burn operation.



Figure 15. Another view of active burn operation at Camp Leatherneck.



Figure 16. Incinerator under construction at Camp Leatherneck.



Figure 17. Another view of incinerator construction at Camp Leatherneck.

## 2.3 Comparison of Solid Waste Generation Rates

The data in Table 7 provide a basis to compare solid waste generation rates reported in detailed base camp studies in the Balkans, with observations and data from CONUS training base camps, and with observations from two base camps in Afghanistan.

CONUS training base camps best fit the characteristics of the GSTM 3.-34.56 “on the move” category based on the expected types of solid waste generated. Training units arrive at these locations with little more than personnel and a small number of vehicles. They typically do not engage in any activities that generate large volumes of solid waste such as major construction or receiving shipments of supplies and equipment. The bulk of solid waste is generated from the DFAC and other Class I products such as “meals ready to eat” (MREs) or bottled water. This nearly replicates the types of waste a military unit might generate during austere initial operations, before a fixed base camp location is developed.

Observations from base camps in Afghanistan generally validate solid waste generation numbers from previous studies. Rates in theater can vary based on the mission, population, maturity of the base camp, and level of and type of construction activities.

Table 7. Solid waste generation rates.

<b>Planning Factors</b>	<b>lb/person/day</b>
Report recommendations	15.9
GSTM 3-34.56 (base camp)	18.2
GSTM 3-34.56 ("On the move")	4
<b>Base Camp Studies</b>	
Camp A 2003	15.8
Camp B 2006	18.2
Force Provider	4.3
<b>CONUS Base Camp Observations</b>	
Camp Atterbury	1.4
Camp Shelby COL 1	1.8
Camp Shelby COL 2	2.4
Camp Shelby COL 3	1.6
Camp Shelby COL 4	2.6
<b>Operation Enduring Freedom (OEF) Base Camp Observations</b>	
FOB Salerno	13.1
Camp Leatherneck	15

### 3 Blackwater Generation

Septage or “blackwater” is latrine wastewater, including waste from flush toilets, septic tanks, port-a-johns, etc. Note that the term “septage” does *not* include “graywater,” which is wastewater from shower, sinks, or vehicle washing.

#### 3.1 General

To determine requirements for septage handling, it is reasonable to start with the basics of human biology, i.e., there is a relatively consistent quantity of wastes that the human body excretes (*excreta or night soil*). Once those figures are clearly understood (or understood within a reasonable range), adjustments to those numbers are simply based on the dilution of the particular toilet technology employed. For example, a flush toilet dilutes the basic excreta to a far greater extent than does a chemical toilet.

The amount of human excreta varies widely depending on diet, water consumption, age (of the person), climate (temperature and humidity), and life (exercise) pattern. *A Guide to the Development of On-Site Sanitation*, published by the World Health Organization (WHO 1992) recommends that, in the absence of local information, the following figures be used as reasonable averages:

- high-protein diet in a temperate climate: 0.12 kg/person/day feces (wet mass), and 1.2 L/person/day urine
- vegetarian diet in a tropical climate: 0.40 kg/person/day feces (wet mass) and 1.0 L/person/day urine.

*The Composting Toilet System Book* (Del Porto and Steinfeld 1999) reported: 0.15 kg/person/day feces (wet mass) and 1.5 L/person/day urine as average generation volumes for composting toilet design criteria in Europe and North America.

Considering that soldiers are young, energetic, and have a high-protein diet, generation volumes of 0.15 kg/person/day feces (wet mass) and 1.5 L/person/day urine appear to be reasonable. Factors affecting extra trash and water volume will differ depending on the purpose, duration, and level of forward camps.

Assuming two flushes per capita per day for feces, and four (urinal) flushes per capita per day for urine (a very crude assumption), would yield 8 gal (30 L) to be added to the night-soil amount, which amounts to about 20 times dilution.

Finally, toilet tissues and other miscellaneous toilet disposal would be expected to increase night soil volume.

### 3.2 Camp Atterbury

Figure 18 shows toilets and wash station at FOB 3. Table 8 lists septage hauling at FOB 3.



Figure 18. Toilets and wash station at FOB 3.

Table 8. Septage hauling, FOB 3.

Unit	Jun-09	Jul-09	Aug-09	Sep-09	Oct-09	Nov-09	Dec-09	Jan-10	Avg
Person	620	1120	570	640	730	350	225	180	554
gal	6750	6750	6750	6750	6750	6750	6750	6750	6750
gal/person-day	0.36	0.20	0.39	0.35	0.31	0.64	1.00	1.25	0.56

## 4 Conclusion

This work was an initial step in an overall effort to improve utility and sustainment protocols at Contingency Base Camps. Specifically, this work characterized and quantified solid waste generation, which includes solid waste (i.e., “trash”) and septage (“blackwater”) generation, “per soldier” and at the base camp level.

### 4.1 Solid waste

While FM 3-34-5 contains no information regarding generation rates of wastes, Army guidance expressed in GSTM 3-34.56 does provide quantified planning information pertaining to solid waste management at future base camps:

- “A soldier in the field can generate 20 pounds of solid waste and 80 pounds of liquid waste per day.”
- “A base camp population of 2,500 can produce approximately 5,500 cubic meters, or 1,500 tons, of compostable solid waste (SW) (including sewage sludge) per year.
- “For units on the move or not situated in a base camp, planners use a generation rate of 4 pounds per person per day as a general rule of thumb.

Field studies done in the Balkans, at CONUS training base camps, and in Afghanistan confirm that, while rates in theater can vary based on the mission, population, maturity of the base camp, and level of and type of construction activities validate the solid waste generation rates given in GSTM 3-34.56.

### 4.2 Septage

Actual quantities of septage to be handled depends on the amounts of feces (wet mass) and urine produced daily, combined with water added during toilet flushes. Literature on the subject of site sanitation, and data from one site study indicate that daily, per-person septage rates range from 0.12–0.4 kg feces and 1.0–1.5 L urine, which, combined with toilet flush dilution would yield up to 8 gal of septage/person/day.

## Acronyms and Abbreviations

Term	Definition
AOR	Area of Responsibility
APG	Aberdeen Proving Ground
CALL	Center for Army Lessons Learned
CEERD	US Army Corps of Engineers, Engineer Research and Development Center
CERL	Construction Engineering Research Laboratory
CHU	Containerized Housing Unit
COL	Contingency Operating Location
CONUS	Continental United States
COR	Contract Officer Representative
DFAC	Dining facility
DOD	US Department of Defense
DPW	Directorate of Public Works
ERDC	Engineer Research and Development Center
EXORD	Execution Order
FOB	forward operating base
FOUO	For Official Use Only
GSTM	General Subject Technical Manual
HQDA	Headquarters, Department of the Army
HQUSACE	Headquarters, US Army Corps of Engineers
ICDT	Integrated Capabilities Development Team
LMI	Logistics Management Institute
LOGCAP	Logistics Civil Augmentation Program
MANSCEN	US Army Maneuver Support Center
MHG	Marine Headquarters Group
MOP	Manual of Practice
MRE	Meal Ready to Eat
NAVICP	Naval Inventory Control Point
NAVSUP	Naval Supply Systems Command
NCOIC	Non-Commissioned Officer in Charge
OEF	Operation Enduring Freedom
OMB	Office of Management and Budget
PAX	Total Personnel
PWTB	Public Works Technical Bulletin
RDECOM	Research, Development, and Engineering Command
SAR	Same As Report
SF	standard form
SW	Solid Waste
TD	Temperature Drop

<b>Term</b>	<b>Definition</b>
TOA	Transfer of Authority
TR	Technical Report
TRADOC	US Army Training and Doctrine Command
US	United States
USAAA	US Army Audit Agency
USACE	US Army Corps of Engineers
USACHPPM	US Army Center for Health Promotion and Preventive Medicine (now known as the US Army Public Health command [USAPHC])
WEF	Water Environment Federation
WHO	World Health Organization
WWTP	Wastewater Treatment Plant
WWW	World Wide Web

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